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Evaluation of the Spatial Disorientation Sortie in Training Aviators

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Following didactic instruction, most aircrew are able to experience some of the disorientating illusions and limitations of the orientation senses in a variety of ground-based devices. In order to reinforce instruction in spatial disorientation (SD) within the environment in which they operate, British Army Air Corps helicopter pilots also receive an airborne demonstration of the limitations of their orientation senses. The objective of this assessment was to determine whether the SD demonstration sortie would be an effective adjunct in training aircrew in SD in the U.S. Army. This paper describes the sortie and records the results of the assessment. Forty-five aviators and training personnel experienced the sortie and provided their opinion in questionnaires. The following conclusions were made: The maneuvers performed in the SD demonstration sortie, and the sortie overall, were extremely effective at demonstrating the limitations of the orientation senses; the SD sortie attracted a significantly higher rating in its effectiveness to train aviators in SD than all the currently available methods; the introduction of the sortie into the initial flight training syllabus would be a distinct enhancement to the SD training of aviators and associated personnel; and the introduction

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19. Abstract

of the sortie into the refresher training in field units also would be an advantage. Recommendations to support these conclusions are made.

Acknowledgments

The authors would like to acknowledge the willing assistance of Mr. Joe Jack Hudgens who piloted some of the demonstrations when USAARL aviators were unavailable.

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Introduction

Spatial disorientation (SD) occurs when a pilot misperceives the position, motion, or attitude of his or her aircraft. Such a misperception may have disastrous effects. SD was considered to be a significant factor in 291 (30 percent) Class A-C helicopter accidents in the U.S. Army in the 8-year period between 1987 and 1995 (Braithwaite et al., 1997). One hundred and ten lives were lost in these accidents, and a cost of nearly $468 million incurred. It should be remembered that only a small proportion of SD episodes lead to accidents, and that nonmishap incidents also impose operational costs in terms of reduced efficiency or abandonment of the mission. In wartime, the risk of SD is heightened by the extra pressure on sensory and cognitive resources. During Operation Desert Shield/Storm, 81 percent of U.S. Army aviation nighttime accidents were ascribed to SD (Durnford et al., 1995).

One of the most important countermeasures to SD is the aviator's awareness of his physiological vulnerability to SD, and the operational circumstances and phases of flight in which SD is most likely to occur. Consequently, all military aviators must attend courses of instruction in SD. Despite regulations that mandate SD training, there is great variability in the quality, quantity, and frequency of this teaching, not only between nations and services within a nation, but within each service itself (Braithwaite, 1994). There is, therefore, room for improvement in all aspects of SD training. The didactic instruction given to ab initio pilots and during refresher courses was addressed by the U.S. Army Aeromedical Research Laboratory (USAARL), Fort Rucker, Alabama, in response to a request from the U.S. Army School of Aviation Medicine (USASAM), Fort Rucker, (Braithwaite, 1997c).

It has been long accepted that demonstration of some of the illusions of SD and the limitations of the orientation senses during ground-based training is a vital part of the proper education of aviators. Most student pilots are given instruction during their flight training on how to overcome the effects of SD, but few air services provide a specific SD demonstration sortie to augment ground-based training. In-flight demonstration of SD reinforces knowledge of the limitations of the orientation senses in flight and enhances aircrew awareness of potentially disorientating situations. In-flight SD training, on the other hand, consists of a series of flight procedures to teach aviators how to cope with disorientating circumstances and illusions (e.g., recovery from unusual attitudes during instrument flying). The teaching of recovery sequences is clearly the responsibility of the flight instructor in both simulator and actual flying sorties, while an in-flight demonstration of SD, although it could be performed by specially trained flight instructors, is best conducted by the flight surgeon who, having performed the ground-based training, is onhand to explain the mechanics of SD.

It was in the pursuance of this philosophy that a specific SD demonstration sortie was developed and has been used by the British Army over the last 15 years. The sortie aims to demonstrate the limitations of their orientation senses to aviators during helicopter maneuvers in flight. The demonstration cannot be conducted in a motion-based simulator because these devices cannot create the appropriate acceleration environment to induce an effective result. A recent analysis compared the incidence of British Army Air Corps SD accidents before and after the SD demonstration sortie was introduced. The analysis revealed that there has been a significant reduction in the rate of SD related mishaps (Braithwaite, 1997a). Although there are confounding factors which affect this finding, it must be concluded that the sortie has been of benefit to British Army helicopter operations. Furthermore, in a survey of 299 British Army helicopter aircrew (Durnford, 1992), 79 percent of aviators regarded the sortie as being a most valuable addition to the aeromedical training syllabus.

Following an OH-58D mishap in 1991, USAARL was requested by USASAM to make recommendations on the demonstration of SD to student aviators. The Laboratory's reply is contained in a memorandum (1993), and recommended that the British Army SD demonstration sortie be considered. No further action was taken on this recommendation. However, recent discussions with aeromedical training staff have indicated that the SD sortie would considerably enhance SD training in the U.S. Army. The objective of this project was, therefore, to determine whether the SD demonstration sortie would be an effective adjunct to the SD training of U.S. Army aviators.

Methods

Under the auspices of USAARL research protocol: "Evaluation of the spatial disorientation demonstration sortie in training aviators," the sortie was demonstrated to a cross section of U.S. Army aviators and associated personnel. Forty-five people (including three "guest" attendees from the U.S. Navy, U.S. Air Force, and Canadian Air Force) experienced the sortie and completed questionnaires detailing their impressions and opinions. The Army personnel were generally from one of four groups: instructor pilots (IPs), flight surgeons, aeromedical training staff, and general aviators.

The UH-1 helicopter used in this demonstration was commanded and flown by an IP with a research flight surgeon conducting the sortie from the copilot's seat. Personnel to whom the sortie was being demonstrated occupied the cabin seats facing forward. Personnel were fully briefed on the nature of the sortie, and before the flight, completed volunteer agreement affidavits and an initial questionnaire asking their opinion on both the impact of SD in Army helicopter operations and the quality of SD training.

Following a transit to the demonstration area, a series of forward flight and hover maneuvers was conducted. In turn, personnel were asked to sit free of the airframe structures other than the seat, note the aircraft's initial flight parameters, close their eyes and lower their dark visor, and as the "subject" for that maneuver, to give a running commentary on their perception of the aircraft's flight path. In this way, the "subject" was deprived of vision, the most important orientational sense, so that the limitations, particularly the unreliability of the nonvisual orientational senses, could be demonstrated. The other two personnel (observers) were asked to observe but not comment until after the maneuver was complete. The flight surgeon then debriefed the individual maneuver. All personnel experienced at least one maneuver in each of the forward flight and hover groups. Following the flight, personnel were asked to complete a further questionnaire asking for their impressions of the sortie.

Maneuvers

The maneuvers and debriefing points are described below. (Although both male and female personnel attended the sortie, for clarity, the description refers to the male gender and, as this was a training exercise, personnel are referred to as "students.")

Forward flight

Level turn

Straight and level flight was established at 90 knots. After 10 seconds, a gently increasing (supra-threshold) roll to 30° angle of bank was commenced while maintaining airspeed and altitude. This was stabilized and, on completion of a turn between 180° and 360°, the aircraft was rolled wings level again at a supra-threshold rate. The subject was told to open his eyes once he considered that he was again straight and level. Debriefing points: the onset of the roll is normally detected, but as the semicircular canal response decays, a false sensation of a return to straight and level flight is perceived. As the roll to level flight is made, a sensation of turning in the opposite direction is perceived. The limitations of semicircular canal physiology are discussed.

Straight and level

Straight and level flight was established at 90 knots and one of the other students was asked to close his eyes. The aircraft was flown with no alteration of altitude, heading, or airspeed. Debriefing points: because of small aircraft movements from turbulence and the aerodynamic response of the helicopter which stimulate the kinaesthetic and/or vestibular apparatus above their threshold, students perceive climb, descents, or turns in unpredictable and varying amounts. The erroneous sensations produced by brief stimulation of the kinaestheic receptors and vestibular apparatus is discussed.

Straight and level deceleration to 30 knots

Straight and level flight was established at 90 knots into wind, and once the subject had closed his eyes, the helicopter was slowed within 30-40 seconds to below 30 knots with no change of heading or altitude. Debriefing points: both the deceleration and the nose-up pitch associated with the attitude change in the final stages of slowing the aircraft usually convinces the subject that a climb is taking place. In addition, a turn is often falsely perceived when balance variations are made to keep straight. The absence of accurate physiological perception of airspeed and the somatogravic illusion are discussed.

Inadvertent descent

This maneuver was commenced from about 500 ft above ground level (AGL). Straight and level flight was established at 90 knots, and the student closed his eyes. While initiating a descent at below 500 feet per minute, a series of turns was commenced. When the aircraft was established in contour flight below 50 feet AGL, the subject was asked to report his heading, height, and airspeed and then open his eyes. Debriefing points: the descent is not usually perceived, and due to the proximity of the ground at the end of the maneuver, this demonstration forcibly and convincingly demonstrates the danger of inadvertent descent.

Hover

As the helicopter has a unique ability to accelerate about, as well as along, orthogonal axes, the final series of demonstrations started from a 5- or 6-foot hover. In turn, the three students were exposed to a variety of linear and rotational movements while maintaining hover height. The flight surgeon kept prompting the subject for a running commentary (to occupy channels of attention) and so exacerbate the onset of SD. Within these exercises various maneuvers were "hidden" so that when the student opened his eyes, a dramatic end point was evident:

- climbing backwards at 10-15 knots.
- landing without the subject realizing it.
- a gentle transition to forward flight.

Debriefing points: most aircrew are able to maintain their orientation for 10 to 15 seconds before losing it. These exercises have a most educational effect upon the subject and observing students. The poor ability to detect linear movements is discussed, and the relevance of physiological orientation limitations in the context of snow, sand, and night operations is emphasized.

Results

The results of this evaluation are based on analysis of the pre- and postflight questionnaire data. Where appropriate, statistical analysis is illustrated under the various questions. Additional comments from those experiencing the SD demonstration sortie are also recorded. Abbreviated copies of the questionnaires are at appendices A and B.

Biographical data

The proportions of employment, parent unit and rank of personnel attending the SD demonstration sortie evaluation are shown in figures 1 through 3 respectively.

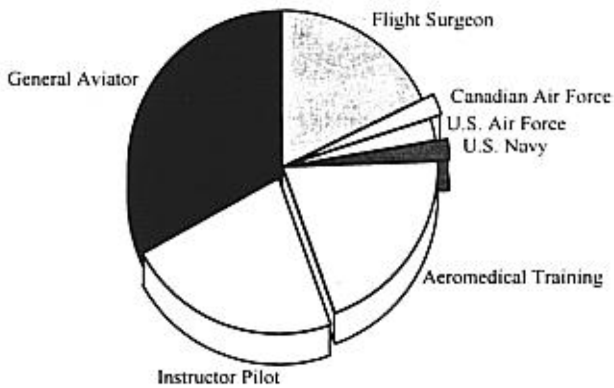
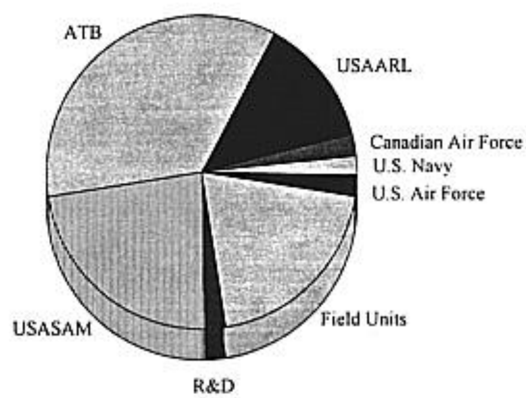


Figure 1. Employment of personnel.



Legend:	ATB	Aviation Training Brigade
	USAARL	U.S. Army Aeromedical Research Laboratory
	USASAM	U.S. Army School of Aviation Medicine
	R&D	Research and Development

Figure 2. Location of parent unit of personnel.

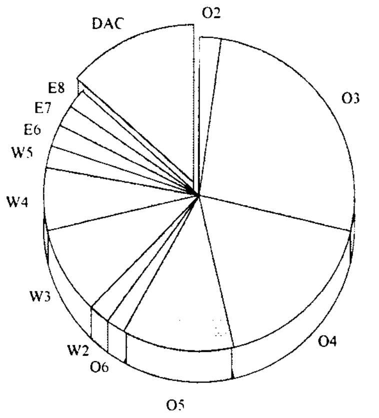


Figure 3. Rank of personnel.
(DAC = Department of the Army civilian)

The distribution of flight hours of personnel attending the SD demonstration sortie evaluation is shown in figure 4.

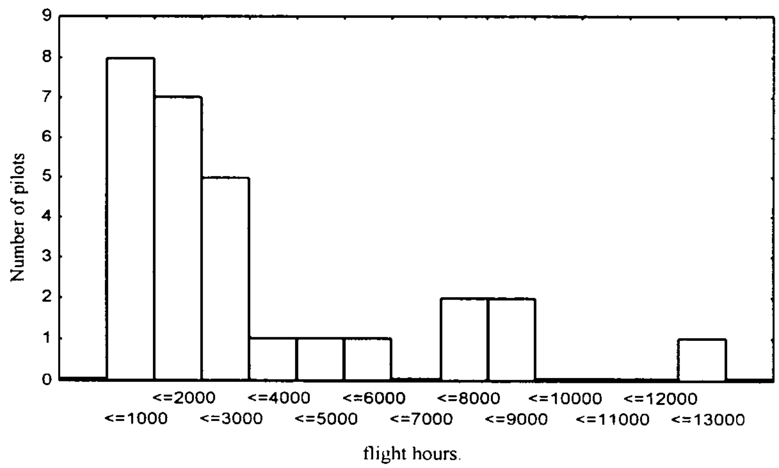


Figure 4. Distribution of flight hours.

Preflight questionnaire data

Assessment of the problem of SD

Question: "In your opinion, SD in Army aviation is......."

The distribution of opinion of the magnitude of the problem of SD is shown in figure 5, and additional comments are made.

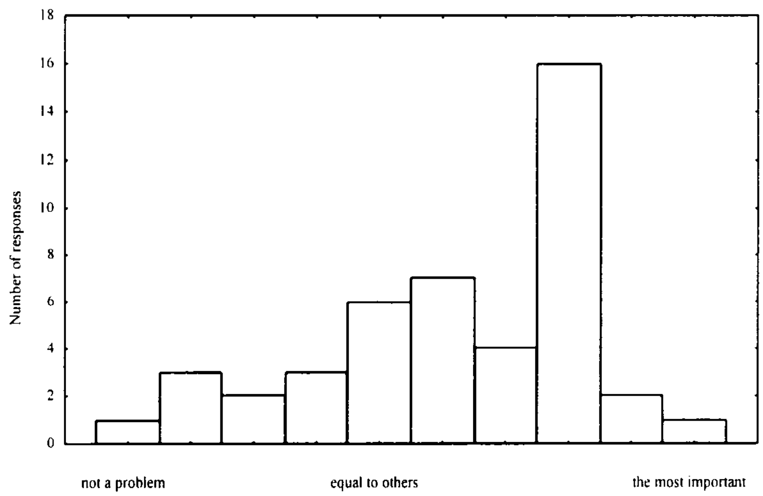


Figure 5. Assessment of the problem of SD.

Comments:

- I personally believe SD is the major cause of all serious mishaps.
- SD needs particular emphasis in noninstrument rated airframes to avoid catastrophic first encounters with disorienting circumstances.
- There is an increased danger of SD in night vision device (NVD) flight.
- The area of SD has not evolved to keep pace with the technological advancements of the modern helicopter. As a result, the aviator is experiencing SD due to a variety of problems, not least of which is task saturation.

Assessment of the standard of SD training

The distributions of opinion of current SD training are shown in figures 6 through 8, and additional comments are made.

Question: "In your opinion, please rate the standard of training in SD that is provided during initial entry rotary-wing (IERW) flight training."

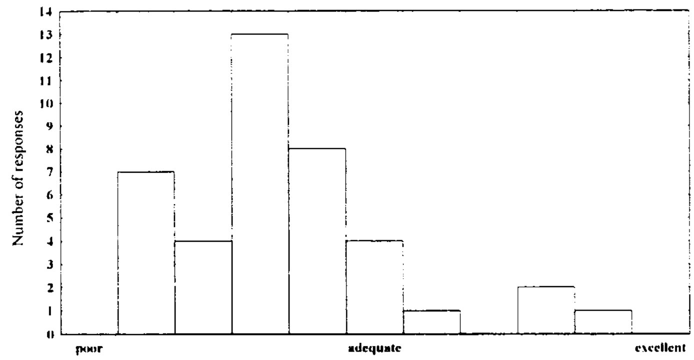


Figure 6. The standard of SD training during IERW flight training.

Comments:

- IERW training should give SD more emphasis in the future than it has in the past.
- SD needs to be stressed and taught more effectively to all crewmembers. (Six people made the same comment).
- Demonstration of SD is limited by the effectiveness of our demonstration equipment.
- Each student should not only be familiar with what leads to SD, but should also experience SD.

Question: "In your opinion, please rate the standard of training in SD that is provided during transition flight training."

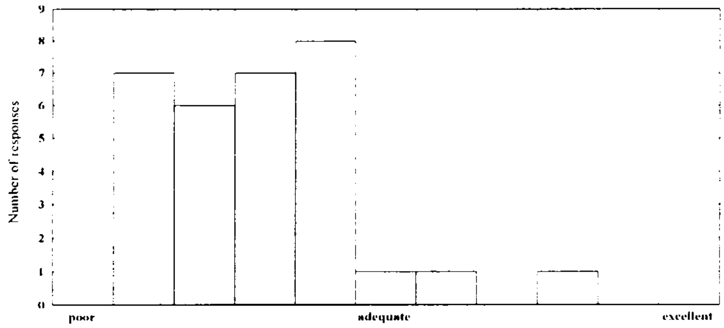


Figure 7. The standard of SD training during transition flight training.

Comments:

- SD is not stressed enough during transition training.
  (Four people made this comment).

- With the exception of oral review of the FM 1-301 topics and unusual attitude recovery, no SD training is conducted.

- Training is nonstandard, uncoordinated, and fails to address SD.

- If there was any training on SD, I don't remember.

Question: "In your opinion, please rate the standard of training in SD that is provided during refresher flight and continuation training in field units."

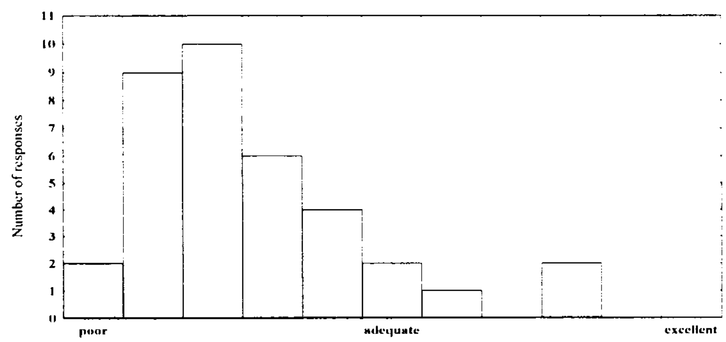


Figure 8. The standard of SD training during refresher flight training.

Comments:

- Little if any SD training is conducted in field units.
  (Three people made this comment).

- The only training conducted is unusual attitude recovery and memorization of illusions without real understanding. There are little or no simulator or airborne SD correction or avoidance procedures taught.
  (Five people made this comment).

- IERW training on SD is viewed by field units to have been sufficient and is rarely taught or reviewed again.

- Both classroom and in-flight training are ineffective or incomplete, or the instructors are poorly trained.

- Generally, SD is just reviewed by the unit flight surgeon on a sporadic basis.

- SD needs additional emphasis in the areas not currently addressed in training.

- I attended refresher training in September, 1995, and SD was not mentioned.

- From personal experience, I feel that SD can lead to accidents and fatalities. Hands-on training would be beneficial.

Assessment of the types of SD training (presortie)

Before the SD demonstration sortie, personnel were asked to rate the types of SD training they had experienced.

Question: "On a scale of 1 to 13 (1 = extremely poor, 7 = adequate, and 13 = excellent), please rate the types of instruction in SD. Do not answer if you have not received that type of training."

Figure 9 shows the median (middle value) of each type of instruction surrounded by a percentile box (representing 50 percent of the distribution of ratings) and whiskers (representing the maximum and minimum rating).

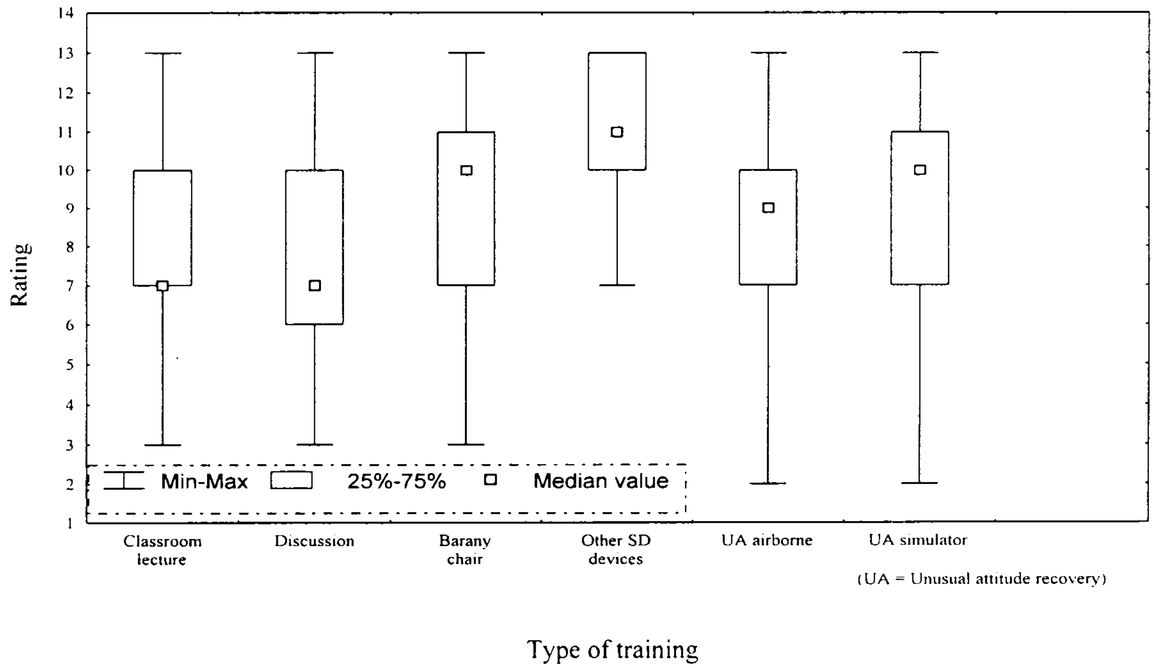


Figure 9. Rating of types of instruction before the SD demonstration sortie.

Comments:

- A lecture on SD is the minimum, but we get no practical experience to reinforce the lectures.
- In group discussions, pilots are hesitant to admit their experiences.
- The Barany chair is good training, but too few students experience it.
- Recovery from unusual attitude training depends on the enthusiasm of IPs.

Statistical testing of the opinion ratings of the types of SD training (t tests for dependent samples) were performed to highlight significant differences. A summary is shown in table 1. The abbreviation for the type of training with the higher average rating is shown in bold type in the cells with significant results.

Table 1.
Summary of t tests of the types of SD training (presortie).

	CL	GD	BC	OSDD	Sim UA
Classroom lecture (CL)					
Group discussion (GD)	t = 0.70 df = 32 p = 0.487				
Barany Chair (BC)	t = 1.26 df = 30 p = 0.216	t = 2.42 df = 24 p = 0.023 **BC**			
Other SD demonstrators (OSDD)	t = 1.71 df = 15 p = 0.107	t = 2.55 df = 14 p = 0.022 **OSDD**	t = 0.76 df = 13 p = 0.461		
Simulator unusual attitude recovery (Sim UA)	t = 1.77 df = 30 p = 0.085	t = 1.98 df = 24 p = 0.058	t = 1.20 df = 20 p = 0.242	t = 0.46 df = 9 p = 0.651	
Airborne unusual attitude recovery (Air UA)	t = 2.95 df = 32 p = 0.005 **Air UA**	t = 3.21 df = 25 p = 0.003 **Air UA**	t = 0.56 df = 21 p = 0.575	t = 0.87 df = 10 p = 0.401 **Air UA**	t = 2.28 df = 29 p = 0.029 **Air UA**

(Shaded cells are nonsignificant)

Postflight questionnaire data

Personnel experiencing the SD sortie were asked to rate each maneuver, and the sortie overall, on its ability to convince them that their nonvisual senses were unable to give them accurate orientation information. The rating scale was from 1 to 13 (1=extremely poor, 7=adequate, and 13=extremely good). The questions, distribution of ratings, and additional comments for the individual maneuvers for both "subjects" and "observers," and the sortie overall are shown in figures 10 through 15. Each graph shows the median (middle value) surrounded by a percentile box (representing 50 percent of the distribution of ratings) and whiskers (representing the maximum and minimum rating). A summary of the average rating scores for each maneuver and the sortie overall is shown in table 2 on page 20.

Level turn

Question: "How successful would you rate the first maneuver (a level turn) in its ability to convince you that it is difficult for you to sense motion and attitude without aircraft instruments?"

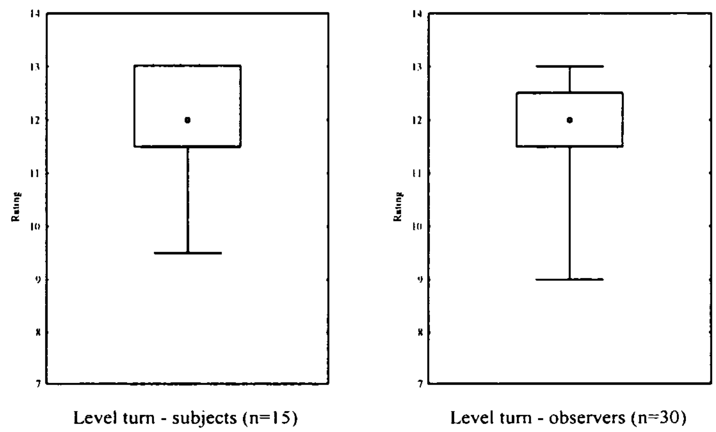


Figure 10. Ratings for the level turn maneuver.

Comments

- It surprised me to learn how much my vision contributes to orientation.
- I felt the initial turn and thought we had leveled off after 15 seconds. (Five people made this comment).
- Excellent demonstration of a subthreshold maneuver.

<u>Straight and level</u>

Question: "How successful would you rate the second maneuver (maintain straight and level) in its ability to convince you that random motion experienced in flight (e.g., turbulence) can give you the wrong information?"

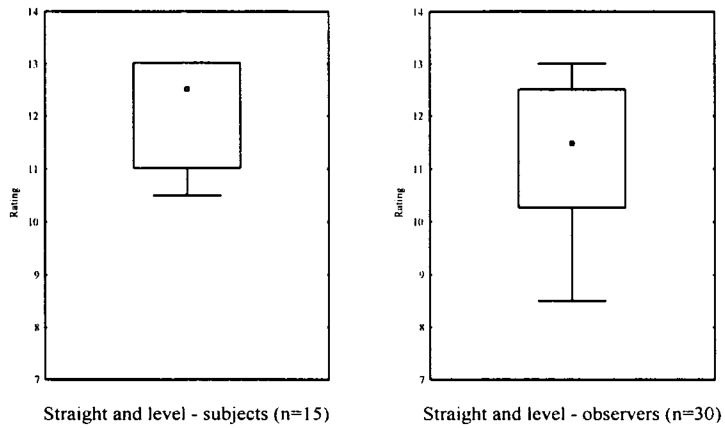


Figure 11. Ratings for the straight and level maneuver.

Comments:

- Visual reference is obviously very important as this maneuver seemed very obvious when observed, but not when experienced as a subject.
- The normal vibration of the aircraft can fool you into thinking that you are climbing or turning.
- A very good demonstration, and hard to detect the real motion.
- I felt as if we were turning to the left, and I never could get rid of this sensation.
- A very clear demonstration, that in the absence of real movement, the mind generates its own.
- Random movements in turbulence completely confused the subject. This demonstration was particularly convincing.
- At each bounce, the subject stated an attitude change.

Straight and level deceleration to 30 knots

Question: "How successful would you rate the third maneuver (deceleration to 30 knots) in its combined ability to demonstrate both the illusion of climbing when the aircraft is pitched nose up, and the inability to accurately detect airspeed changes without reference to flight instruments?"

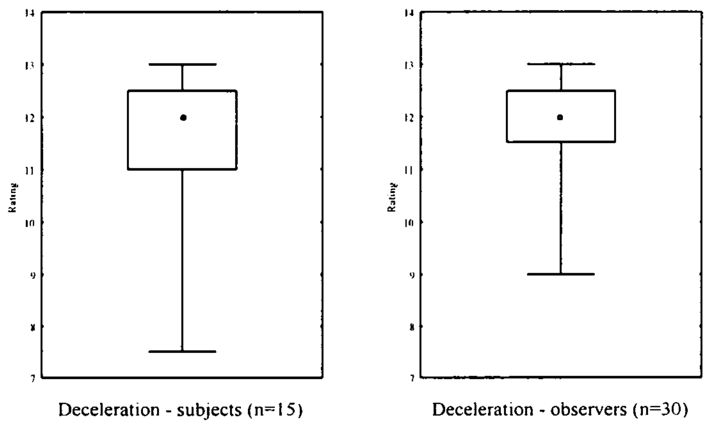


Figure 12. Ratings for the straight and level deceleration to 30 knots maneuver.

Comments:

- The subject was unable to perceive the correct motion. He thought that we were climbing rather then decreasing speed.

- The maneuver went exactly as planned. I really thought we were in a climb.

- One's vestibular system simply cannot keep up with motion changes without visual reference.

- The subject actually believed the aircraft was climbing, which was a surprise for me (with my eyes open). Also, as he was unfamiliar with the UH-1, he didn't detect the deceleration from changes in the blade noise.

- This maneuver was conducted on a day with windy gusts. However, it clearly demonstrated that in the absence of visual cues, you have no idea that you are decelerating while maintaining altitude.

- From my auditory sense, I had some cue of deceleration or descent, but could not accurately judge which, or determine the magnitude, of change.

- The subject was completely fooled as would I have probably been.
- Great maneuver, the climb is definitely felt towards the end of the maneuver.

Inadvertent descent

Question: "How successful would you rate the fourth maneuver (inadvertent descent) in its ability to convince you that it is difficult to accurately sense the position, motion, and attitude of the aircraft when close to the ground in conditions of poor visibility?"

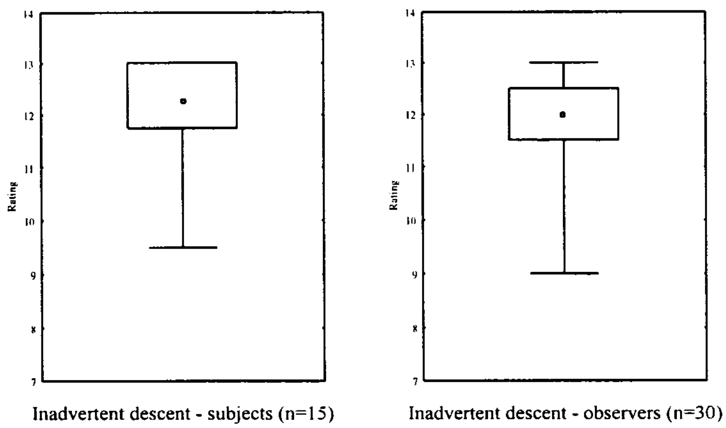


Figure 13. Ratings for the inadvertent descent maneuver.

Comments:

- The descent was grossly underestimated by the subject.
- I felt the initial descent, and that we were turning right. I thought that I descended only 200-300 feet. Upon opening my eyes, I saw we were only 100 ft above the ground.
- I had no idea of altitude at all.
- I could not tell we were descending to the ground.
- Changes in altitude were impossible to feel. All perceptions were based on changes in pitch attitude.
- A clear demonstration that a series of turns can effectively hide large losses in altitude.

- I really thought we were climbing.

- With a gradual descent one never feels the descent after the initial motion.

- Very impressive - the descent should be slow to mask eustachian tube equalization.

- Excellent demonstration - the best of the forward flight series.

Hover maneuvers

Question: "How successful would you rate this demonstration in its ability to convince you that it is difficult to accurately sense the position, motion, and attitude of the aircraft when close to the ground in conditions of poor visibility?"

Personnel were asked to rate their experience of the hover maneuvers as a whole.

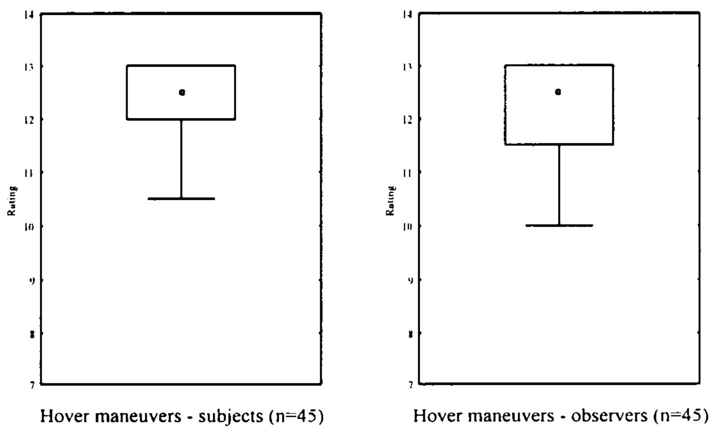


Figure 14. Ratings for the hover maneuvers.

Comments:

- The best of the maneuvers.

- Although our heading did not change, I felt that we were turning but could not feel the drift. This demonstrated extremely well that we cannot sense small changes in direction or height when we lose visual cues.

- During this maneuver, I thought we were in a right pedal turn, then a left pedal turn, when we were actually on the ground.

- I was completely disoriented as a subject. This is a good exercise to show Apache pilots that, in the hover at night, they cannot trust their instincts.

- I could not tell when we were drifting backwards or sideways at all.

- It was even more difficult to perceive orientation in the hover than in the forward flight demonstrations.

- One tends to try to anticipate movement and cannot perceive these changes without good visual references.

- I recall my earliest demonstration regarding the cumulative degrading effects of SD in 1982. I was unable to accurately determine my aircraft's attitude and position. Now, 14 years and 7000 flight hours later, I am no better.

- Only attitude and yaw changes could be felt. No drift could be felt at all. The cumulative affect was complete disorientation.

- I was really amazed that I could not detect the lateral drifts while at a hover. I now know why we have so many blade and tail strikes.

- Excellent demonstration on how easy the senses are fooled. We were sitting on the ground, and yet I thought we still flying.

- Graphically demonstrates what could happen in whiteout or brownout.

- Landing from hover while I was convinced of motion worked very well.

- Clearly convinced me that I could not accurately perceive the aircraft motion at a hover without visual reference.

- I am truly convinced that without visual references anyone can be fooled.

- Subjects were unable to accurately determine translation. Rotation was more easily detected.

- When listening to the subject's narrative, one can easily see how there is sensory confusion without visual reference.

- I found it very instructive to witness how limited our sensory perceptions are, and the inaccuracies in the conclusions the mind reaches in the absence of accurate feedback.

- The demonstration where the aircraft landed while the observer continued to report movement was eye-opening.

- Each subject was disoriented as to their position and motion.

- Reinforced my respect for SD.

<u>The sortie overall</u>

Question: "Overall, how well did this demonstration sortie show the limitations of the orientation senses in flight?"

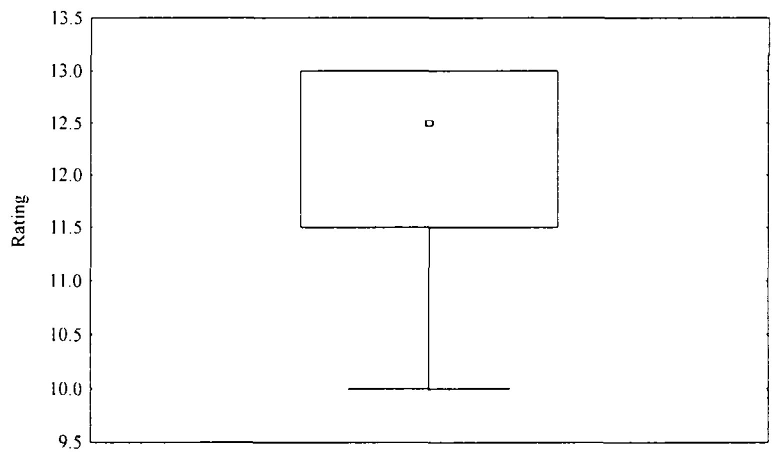


Figure 15. Ratings for the SD demonstration sortie overall.

Comments:

- One is not really aware of sensory limitations until an experience like this.

- This demonstration reinforces all previous academic training to make a more lasting impression.

- Done very well. Demonstration of the limitations is a lot better than the Barany chair.

- Excellent demonstration. It really highlights how easily SD can occur when some of the normal visual references are masked.

- Even with vision, SD can occur (e.g., flight over water without a horizon, flight over sand, etc.). I welcome any way to demonstrate this fact and teach pilots that at times they must rely totally on instrumentation.

- This was the most effective demonstration of the limitations of SD that I have ever experienced. All helicopter pilots need this demonstration before they graduate from flight school.

- A "humbling" experience!

- The sortie certainly changed my mind about the significance of the potential for the "seat of the pants sensation" to really get you in trouble in a helicopter.

- With the high proportion of accidents attributed to SD, this sortie should be incorporated into flight school. The money spent to conduct training would be recovered through a decreased accident rate.

- I was aware of the limitations of orientation senses, but not how easily they could be "tricked" by normal flight maneuvers.

- This was the best and most practical demonstration I have seen to date.

- A great sortie.

Table 2.
Summary of average rating scores for SD sortie maneuvers.

Maneuver	Average score
Level turn	11.65
Straight and level	11.57
Straight and level deceleration to 30 knots	11.73
Inadvertent descent	11.94
Hover (maneuvers experienced as a "subject")	12.31
Hover (maneuvers experienced as an "observer")	12.06
The sortie, overall	**12.22**

Awareness of the limitations of the orientation senses following the SD demonstration sortie

Question: "Compared with your awareness of the limitations of the orientation senses in flight before the sortie, how would you rate your knowledge now?"

The rating scale was from 1 to 13 (1=I know nothing about SD, 7=the same as before, and 13=totally enlightened). The distribution of responses to this question is shown in figure 16. The average rating score was 10.73, which, on this scale, equates to a mark above "better than before."

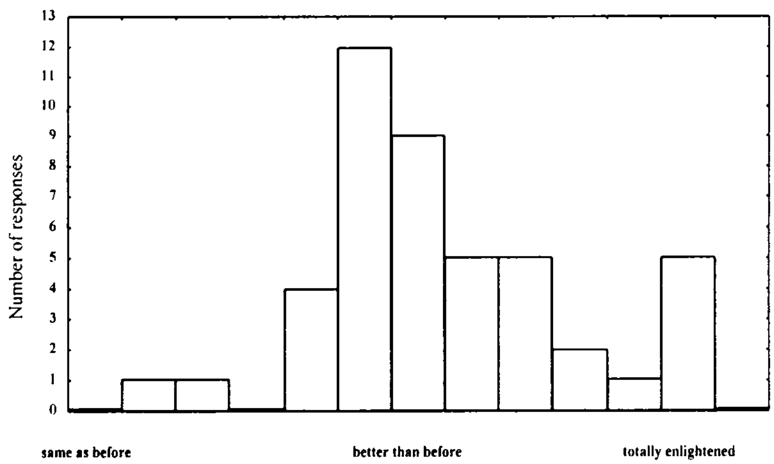


Figure 16. Assessment of "awareness" of the limitations of orientation.

Assessment of the types of SD training (postsortie)

Question: "On a scale of 1 to 13 (1 = extremely poor, 7 = adequate, and 13 = excellent), please rate the types of instruction in SD. Do not answer if you have not received that type of training."

This question was a repeat of question 5 that personnel had completed before the sortie, but now included the SD sortie as a form of instruction. Figure 17 shows the median (middle value) of each type of instruction surrounded by a percentile box (representing 50 percent of the distribution of ratings) and whiskers (representing the maximum and minimum rating).

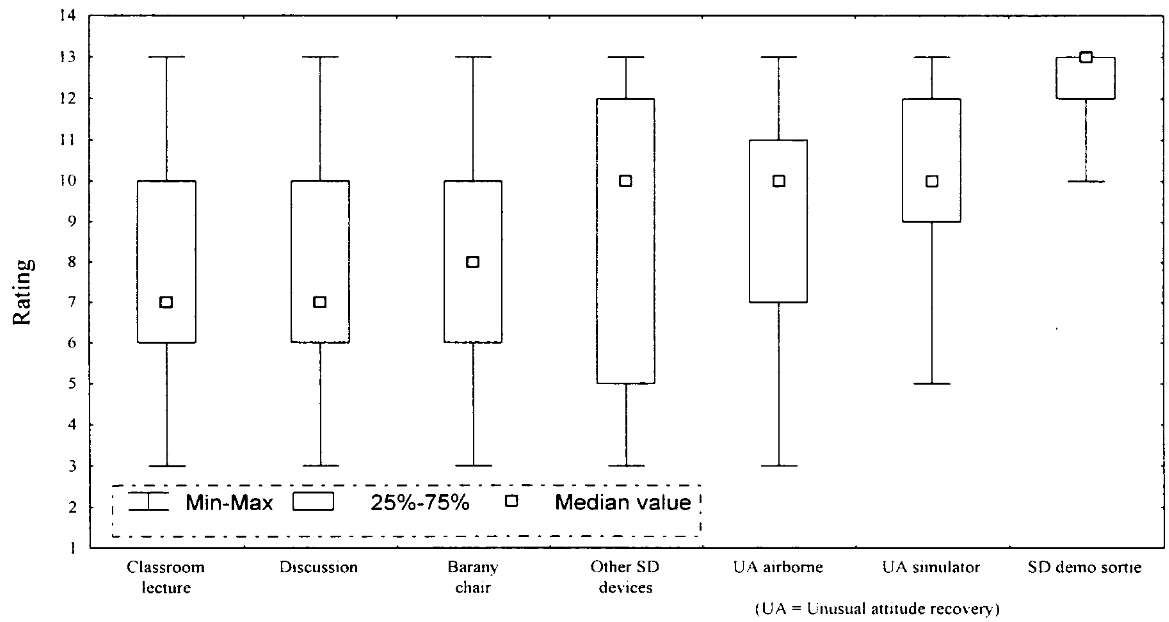


Figure 17. Rating of instruction after the SD demonstration sortie.

Comments:

- I thought that the SD demonstration sortie was much better than the advanced spatial disorientation demonstrator (ASDD) that the U.S. Air Force uses at Brooks Air Force Base, TX. It makes the ASDD seem insignificant. (Note: Aeromedical training instructors have the opportunity to experience the ASDD. This device is a complex electro mechanical centrifuge that has been developed to demonstrate various aspects of SD. It utilizes fixed wing profiles, most of which have little relevance to the rotary-wing manifestations of SD.*)*

- The sortie is an excellent demonstration. It is much more realistic and drives the point home a lot better than the Barany chair.

Statistical testing of the opinion ratings of the types of SD training (t tests for dependent samples) were performed to highlight significant differences. A summary is shown in table 3. The abbreviation for the type of training with the higher average rating is shown in bold type in the cells with significant results.

T tests were also performed to compare ratings of individual types of instruction before and after the sortie. Only the rating of the rotating chair was significantly different. The mean rating before the sortie was 8.93, and 8.17 afterwards ($t = 2.21$, $df = 28$, $p = 0.035$).

Table 3.
Summary of t tests of the types of SD training (postsortie).

	CL	GD	BC	OSDD	Sim UA	Air UA
Classroom lecture (CL)						
Group discussion (GD)	t = 0.58 df = 40 p = 0.563					
Barany Chair (BC)	t = 0.70 df = 28 p = 0.488	t = 1.31 df = 25 p = 0.202				
Other SD demonstrators (OSDD)	t = 0.92 df = 14 p = 0.374	t = 1.99 df = 13 p = 0.067	t = 2.10 df = 12 p = 0.057 **OSDD**			
Simulator UA recovery (Sim UA)	t = 3.47 df = 28 p = 0.002 **Sim UA**	t = 3.26 df = 25 p = 0.003 **Sim UA**	t = 0.78 df = 18 p = 0.440	t = 3.81 df = 7 p = 0.657		
Airborne UA recovery (Air UA)	t = 5.29 df = 29 p = 0.000 **Air UA**	t = 4.82 df = 27 p = 0.000 **Air UA**	t = 1.44 df = 19 p = 0.165	t = 3.94 df = 8 p = 0.683	t = 1.39 df = 26 p = 0.036 **Air UA**	
SD demonstration sortie (SDS)	t = 13.48 df = 44 p = 0.000 **SDS**	t = 10.18 df = 40 p = 0.000 **SDS**	t = 7.00 df = 28 p = 0.000 **SDS**	t = 3.69 df = 14 p = 0.002 **SDS**	t = 6.20 df = 28 p = 0.000 **SDS**	t = 2.20 df = 29 p = 0.000 **SDS**

(Shaded cells are nonsignificant)

Introduction of the SD sortie into Army flight training

Personnel were asked whether they thought that a similar sortie should be introduced to the various phases of U.S. Army aeromedical and flight training. The results are represented in figure 18, and comments are recorded below.

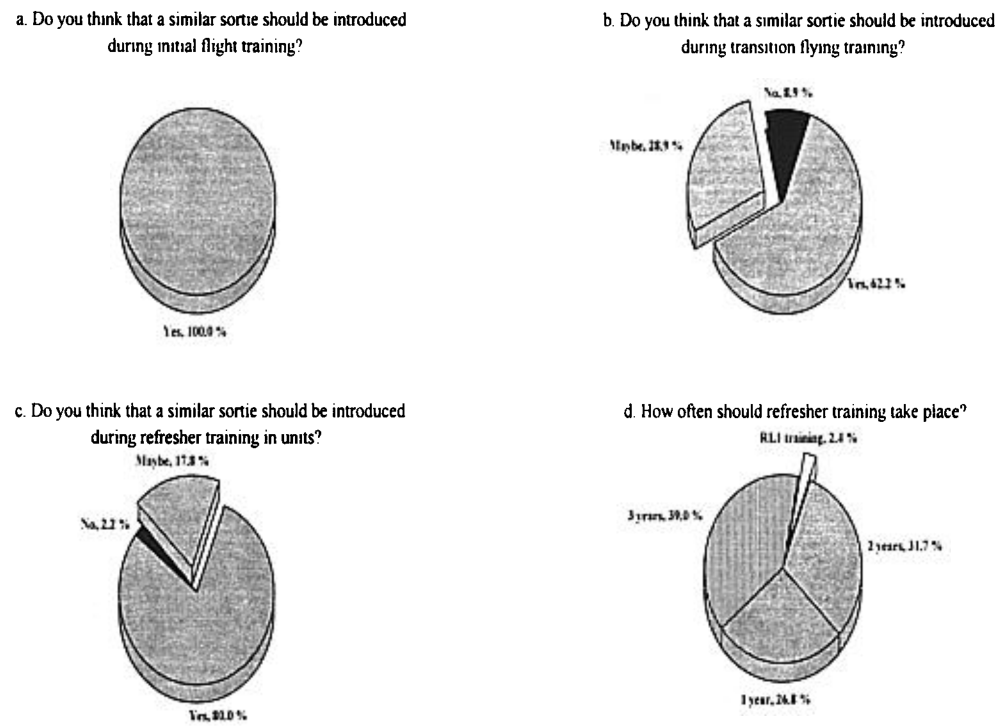


Figure 18. Introduction of the SD demonstration sortie.
(RL1 = readiness level 1)

Comments on the introduction of the sortie into IERW course:

- This training must be integrated into the program for all crewmembers.
- Inclusion of this demonstration will awaken the new pilots from day one.
- Time needs to be added back into the program of instruction of IERW courses prior to instrument flight training for this excellent demonstration of disorientation.

- The SD sortie should be tied to training in instruments. Likewise, the SD lecture should be scheduled close to the demonstration for reinforcement.

- The training should be a stand alone requirement for all IERW students. It should be a dedicated period, not crammed into an existing block. (Note: This comment was from a very experienced Aviation Training Brigade (ATB) standardization officer).

- I vividly recall each training period involving SD. Given the limitations of our bodies and the inability to train SD, such experiences convince me that awareness truly is the first step towards prevention.

The comments on the introduction of the sortie into transition training generally supported one of two views. First, those that felt that SD training should be stressed at every possible opportunity supported a further demonstration at this stage. Second, those who realized the fiscal constraints stated that while it would be highly desirable to repeat the sortie during transition training, it was probably not essential. This latter view was qualified by ensuring the maintenance of a high quality of instruction during IERW courses.

Comments on the introduction of the sortie into refresher training in field units:

- Reminders never hurt. We cannot make the assumption that individuals will have been exposed to conditions which produce SD.

- The sortie could be incorporated into the annual proficiency and readiness test (APART) as a task. (Ten people made the same comment including two highly experienced ATB standardization officers).

- Money spent to conduct this training would be directly recovered through a decrease in the SD accident rate.

- The demonstration sortie should be designed as an exportable package that could be easily implemented.

- This needs to be a carefully flown demonstration for full effect. Sloppy flight demonstrations in the field might hurt rather than help education.

Discussion

This project set out to determine whether the SD demonstration sortie would be an effective adjunct in training aircrew in SD in the U.S. Army. The cross-section of aviators included a number of very experienced standardization instructor pilots (SIP) whose comments were most valuable. The following conclusions can be made from analysis of the questionnaire results:

- SD is a significant hazard associated with Army helicopter operations.
- The quality of SD training in the U.S. Army during initial, transition, and refresher training is less than adequate, and should be improved to reflect the significance of the hazard. In particular, it should receive greater attention during refresher training periods, and demonstration of the limitations of the orientation senses should be improved.
- The maneuvers performed in the SD demonstration sortie, and the sortie overall, were extremely effective at demonstrating the limitations of the orientation senses.
- The SD sortie was given a significantly higher rating in its effectiveness to train aviators in SD than all the currently available methods.
- The introduction of the sortie into the IERW flight training syllabus would be a distinct enhancement to the SD training of aviators and associated personnel.
- The introduction of the sortie into the refresher training in field units would also be an advantage.

The following final comment from one of the SIPs attending the SD demonstration sortie is reproduced below because it succinctly summarizes the advantages of this enhancement to SD training:

> "The demonstration was extremely beneficial because it so clearly demonstrated the physical limitations of our orientation system. As an instructor, I am enthused about the potential benefits to aviator training. I had stated on the pre-flight questionnaire that I didn't think too many Army aviation accidents were related to SD, but I was wrong to say this. My scope was limited to actual instrument flight operations, but the application for this innovation is broad, covering all operations (particularly night vision device and hover operations). We can attribute a lot of accidents to failures to maintain aircraft position. The Army needs to buy in to this proposed training without reservation."

It is stressed that this demonstration does not seek to train the aviator how to deal with SD once it has occurred. That is the responsibility of the IP, and the standardization of this issue, although not within the scope of this report, is being addressed under the auspices of the triservice technical working group (TWG) on SD and situational awareness.

A technical memorandum (Braithwaite, 1997b) which briefly described these results has already been distributed so that a timely decision could be made to determine the feasibility of incorporating the demonstration in the flight training syllabus. Both the commander of the ATB and the Dean of USASAM accepted the conclusions without reservation, and a feasibility study to introduce the sortie into IERW training has been started.

As the project was concluded to be successful, the following section addresses the requirements for introduction of the sortie into flight syllabi. A lesson plan, and a critique sheet to be completed by students, and so monitor the introduction of the sortie, are included at appendix C and D respectively.

Requirements for introduction of the SD demonstration sortie

In order to assist those tasked with assessing the feasibility of enhancing training by inclusion of this sortie, the experiences of the British Army in conducting the sortie are described. During initial rotary-wing training, the SD demonstration sortie is flown before helicopter instrument flying is scheduled, and about 3 to 4 weeks after the aeromedical training module (which itself is conducted after aviators have had about 50 hours of preliminary fixed wing training and 20 hours of helicopter flying). Three students are flown on each sortie which lasts approximately 30 minutes. Mission time primarily depends on the time taken to transit between the base airfield and a suitable location, as the maneuvers themselves can be completed in about 25 minutes.

Cost

Any additional flight training bears a cost both in terms of money and time spent training. Using the criteria described above, if three students attended each flight, the financial cost per student would be approximately 0.165 (0.33 x 0.5) of the hourly operating cost of the chosen aircraft. In the British Army, the Gazelle (SA 341) is used to fly the sortie. Using 1996 military operating costs, a charge of $137.00 per student has been calculated. The total cost over nearly 15 years of this training has been $252,000 or an average annual sum of just over $18,000. The overall figure is less than one tenth of the replacement cost of the least expensive in-service British Army helicopter. It would take many years of training at this cost to justify the purchase of a modern electro-mechanical demonstrator (e.g., the ASDD).

The time spent performing the demonstrations to a class (or group of aviators for refresher training) can be minimized by doing "rotor-turning" crew changes. In the British Army, class sizes are usually 12 students, so 4 sorties can be completed within approximately 2 hours.

If enhanced awareness of the hazard of SD is achieved as a result of this training, a reduction in the U.S. Army SD accident rate would be expected (see the Introduction section for statistics). Therefore, the additional cost of this training would be quickly justified.

Whether the SD demonstration sortie should replace an existing scheduled training flight is beyond the scope of this report.

Target students

The results of this assessment indicate that IERW students at Fort Rucker would greatly benefit from this training. The priority should, therefore, be to target this population first, and then assess the progress after a 6- to 12-month period. If this initial "trial" is successful, refresher training should be introduced into field units. The timing of the placement of the SD sortie into the flight syllabus is of great importance. It should be conducted after a period of flight training so that the student can relate the limitations of his senses to the flight environment, precede instrument flight training, and be fairly soon (3-4 weeks) after aeromedical instruction on SD. This may necessitate rescheduling the SD instruction presently given at USASAM. Following a review of SD training (Braithwaite, 1997c), instructional staff at USASAM have indicated support for this proposal.

Conduct of the sortie

In the United Kingdom, Army flight surgeons are qualified pilots and both fly and conduct the sortie. It is understood that unlike their British counterparts, U.S. Army flight surgeons are not rated aviators. Sorties should, therefore, be flown by an IP, but it is essential that a flight surgeon conduct the sortie, preferably from the other front crew seat. The flight surgeon will have performed the ground-based training, and should, therefore, be on-hand to explain the mechanics of SD. Both flight surgeons and IPs would, therefore, be required to be trained to conduct the sortie. Because of his previous experience, the British exchange research flight surgeon at USAARL must be regarded as an expert in the conduct of this sortie. There is no reason to believe that the exchange program will not continue, so there will be a ready source of a competent officer to initiate and continue training for the foreseeable future.

Type of helicopter

The type of helicopter used to conduct this sortie should be capable of carrying seated, forward-facing passengers in the rear cabin and enable them to have a reasonable view of the instrument panel and through the front windshield. Those experiencing the sortie should not face backwards or sideways because they would not be exposed to the same direction of accelerative forces with which they are familiar as front seat crewmembers. The UH-1, as used in this assessment, is considered ideal, especially as it is the aircraft used for IERW instrument flight training. It may be possible to utilize the TH-67 or OH-58, but a restriction to two students may be necessary, with a consequently higher cost of training. Using the UH-60 is a possibility, but forward-facing cabin passengers in this aircraft have a restricted view of the instrument panel, and it also may be too large for some of the hover maneuvers. Neither the CH-47 nor the AH-64 are suitable, as the former is too large, and the latter cannot carry passengers.

Flight surgeon and IP training

During the preparatory phase of the assessment described in this memorandum, three IPs and three flight surgeons from USASAM were trained to conduct the sortie by the British exchange research flight surgeon at USAARL. The training and practice sessions for each IP was performed individually and took approximately 1.5 hours. This training time could be reduced if several IPs were shown the sortie simultaneously. The core of aeromedical training expertise should continue to be at USASAM, with new flight surgeons being trained as they attend the flight surgeon course. A group of the IPs who currently train IERW aviators could be trained by the flight surgeons at USAARL and USASAM, who are now familiar with the sortie, while IPs selected for training on the chosen helicopter type could be trained during their course.

Recommendations

The following recommendations are made:

- The SD demonstration sortie should be introduced into the Army flight syllabus for a trial period of 12 months.
- A working group be established to consider the feasibility and associated issues concerned with the introduction of the sortie. A suggested membership is the USAARL British exchange research flight surgeon, SIPs from ATB, and instructors from USASAM.

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Braithwaite, M.G., Groh, S., Alvarez, E.A. 1997.
Spatial disorientation in U.S. Army helicopter accidents: An update of the 1987-92 survey to include 1993-95. Fort Rucker, AL: U.S. Army Aeromedical Research Laboratory. USAARL Report No. 97-13.

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Disorientation and flight safety - a survey of UK Army aircrew. In AGARD CP 532 Sep 1992.

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Spatial disorientation: A survey of U.S. Army helicopter accidents 1987-92. Fort Rucker, AL: U.S. Army Aeromedical Research Laboratory. USAARL Report No. 95-25.

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Appendix A.
Abbreviated initial questionnaire

SPATIAL DISORIENTATION DEMONSTRATION SORTIE INITIAL QUESTIONNAIRE

Thank you for agreeing to assess the Spatial Disorientation Demonstration Sortie.

Please answer the questions below. You may be assured that the information contained in this questionnaire will be treated with the utmost confidentiality and not revealed to any person or agency outside the Spatial Disorientation Team of USAARL.

******** **SD is used as an abbreviation for Spatial Disorientation** ********

Biographical details

Name(first and last) .... Rank ....

Age .... Sex (circle one) Male / Female

Contact telephone number (in case of queries) ....
with area code

Unit .... Present position / job ....

Location ....

Please circle the classification that describes your position **best**:

Staff Officer   Flying training   Aeromedical training   Flying Standards

Flight Safety staff   General aviator   Other (please specify).......................................

Total flying hours (civilian + military to nearest 50 hours) ....

Please turn over

Where you are asked to mark the line scale, please do so as shown in the following example.

EXAMPLE

Extremely poor | Poor | Adequate | Good | Excellent

_|_ _|_ X _|_ _|_ _|_ _|_ _|_ _|_ _|_ _|_ _|_ _|_ _|_

****

1. In your opinion, Spatial Disorientation (SD) in Army aviation is ....
(Please place an **X** at the point on the scale below that most clearly represents your opinion.)

not a problem | a minor problem | equal to other problems | a major problem | the most important problem

_|_ _|_ _|_ _|_ _|_ _|_ _|_ _|_ _|_ _|_ _|_ _|_ _|_

Any further comments on this question: ....

2. When did you last receive aeromedical instruction in SD?

Month (if known)............................. Year................................

Please turn over

3. In your opinion, please rate the standard of training in SD that is provided in the U.S. Army **during initial flight training.**
(Please place an **X** at the point on the scale below that most clearly represents your opinion.)

Extremely poor	Poor	Adequate	Good	Excellent

Any further comments on this question: ....

4. In your opinion, please rate the standard of training in SD that is provided in the U.S. Army **during transition flight training.**
(Please place an **X** at the point on the scale below that most clearly represents your opinion.)

Extremely poor	Poor	Adequate	Good	Excellent

Any further comments on this question: ....

Please turn over

5. In your opinion, please rate the standard of training in SD that is provided in the U.S. Army **during refresher and continuation flying training in field units.**
(Please place an **X** at the point on the scale below that most clearly represents your opinion.)

Extremely poor	Poor	Adequate	Good	Excellent

_|__|__|__|__|__|__|__|__|__|__|__|__|_

Any further comments on this question: ....

6. On a scale of **1** to **13** (**1** = extremely poor, **7** = adequate and **13** = excellent) please rate the following **types** of instruction in SD. **Rate as 0 if you have no experience of that type.**

Type of instruction	**Rating**	**Remarks**
Classroom lecture		
Group discussion about SD experiences		
Rotating chair		
A SD demonstrator (e.g. electro mechanical device)		
Airborne demonstration sortie		
Simulator Recovery from Unusual attitudes with IP		
Airborne Recovery from Unusual attitudes with IP		
OTHER (please specify)		

THANK YOU - PLEASE RETURN THE COMPLETED QUESTIONNAIRE TO THE RESEARCH TEAM

Appendix B.
Abbreviated postsortie questionnaire

Name .... Date ....

No matter whether you were a "subject" (i.e. had your eyes closed) or an "observer" (i.e. were watching the reaction of the subject) please rate all of the demonstration maneuvers.

Where you are asked to mark the line scale, please do so as shown in the following example.

EXAMPLE

Extremely poor — Poor — Adequate — Good — Excellent

X

a. Maneuver 1 : level turn

CHECK ONE BOX ONLY. For this maneuver I was the subject ☐ an observer ☐.

How successful would you rate the first maneuver (a level turn) in its ability to convince you that it is difficult for you to sense motion and attitude without aircraft instruments?
(Please place an **X** at the point on the scale below that most clearly represents your opinion.)

Extremely poor — Poor — Adequate — Good — Extremely good

Any further comments on **this** maneuver: ....

 Please turn over

b. Maneuver 2 : Straight and level

CHECK ONE BOX ONLY. For this maneuver I was the subject ☐ an observer ☐.

How successful would you rate the second maneuver (maintain straight and level) in its ability to convince you that random motion experienced in flight (e.g., turbulence) can give you the wrong information. (Please place an **X** at the point on the scale below that most clearly represents your opinion.)

Extremely poor	Poor	Adequate	Good	Extremely good

Any further comments on **this** maneuver: ....

c. Maneuver 3 : Deceleration to a free air hover

CHECK ONE BOX ONLY. For this maneuver I was the subject ☐ an observer ☐.

How successful would you rate the third maneuver (deceleration to a free air hover) in its **combined** ability to demonstrate **both** the illusion of climbing when the aircraft is pitched nose up, and the inability to accurately detect airspeed changes without reference to flight instruments.
(Please place an **X** at the point on the scale below that most clearly represents your opinion.)

Extremely poor	Poor	Adequate	Good	Extremely good

Any further comments on **this** maneuver: ....

Please turn over

d. **Maneuver 4 : Inadvertent descent**

CHECK ONE BOX ONLY. For this maneuver I was the subject ☐ an observer ☐.

How successful would you rate the fourth maneuver (inadvertent descent) in its ability to convince you that it is difficult to accurately sense the position, motion and attitude of the aircraft when close to the ground in conditions of poor visibility.
(Please place an **X** at the point on the scale below that most clearly represents your opinion.)

Extremely poor — Poor — Adequate — Good — Extremely good

Any further comments on **this** maneuver: ....

e. **Maneuver 5 : Hover maneuvers**

You will have been a **subject** on one occasion for hover maneuvers and an **observer** on two occasions.

Please rate your experience as a **subject** here.

(e.1) Hover maneuver as a subject

How successful would you rate this demonstration in its ability to convince you that it is difficult to accurately sense the position, motion and attitude of the aircraft when close to the ground in conditions of poor visibility.
(Please place an **X** at the point on the scale below that most clearly represents your opinion.)

Extremely poor — Poor — Adequate — Good — Extremely good

Any further comments on **this** maneuver: ....

Please rate your **combined** experience as a **observer** here.

(e.2) Hover maneuvers as an observer

How successful would you rate these demonstrations in their ability to convince you that it is difficult to accurately sense the position, motion and attitude of the aircraft when close to the ground in conditions of poor visibility.
(Please place an **X** at the point on the scale below that most clearly represents your opinion.)

Extremely poor — Poor — Adequate — Good — Extremely good

Any further comments on **this** maneuver: ....

f. **Overall**, how well did this demonstration sortie show the limitations of the orientational senses in flight?
(Please place an **X** at the point on the scale below that most clearly represents your opinion.)

Extremely poorly — Poor — Adequately — Good — Extremely well

Any further comments on this question ....

Please turn over

g. Compared with your **awareness** of the limitations of the orientational senses in flight **before** the sortie, how would you rate your knowledge now?
(Please place an **X** at the point on the scale below that most clearly represents your opinion.)

I know nothing about SD	Worse than before	The same as before	Better than before	Totally enlightened

Any further comments on this question ....

h. Do you think that a similar sortie should be introduced to U.S. ARMY aeromedical and flight training **during INITIAL flying training**.

CHECK ONE BOX ONLY.

Yes ☐ No ☐ Maybe ☐ (please state your reservations)

Further comments ....

j. Do you think that a similar sortie should be introduced to U.S. ARMY aeromedical and flight training **during TRANSITION flying training to an aviator's operational aircraft.**

CHECK ONE BOX ONLY.

Yes ☐ No ☐ Maybe ☐ (please state your reservations)

Further comments ....

Please turn over

k. Do you think that a similar sortie should be introduced to U.S. ARMY aeromedical and flight training **during REFRESHER flying training at unit bases.**

CHECK ONE BOX ONLY.

Yes ☐ No ☐ Maybe ☐ (please state your reservations)

Further comments ....

l. If you answered **YES** to the previous question, how often should refresher training take place?

CHECK ONE BOX ONLY.

Every 1 year	Every 2 years	Every 3 years	Every 4 years	Every 5 years	Other (please state)
☐	☐	☐	☐	☐	☐ ....

Further comments ....

m. On a scale of **1** to **13** (**1** = extremely poor, **7** = adequate and **13** = excellent) please rate the following **types** of instruction in SD. **Rate as 0 if you have no experience of that type.**

Type of instruction	**Rating**	**Remarks**
Classroom lecture		
Group discussion about SD experiences		
Rotating chair		
A SD demonstrator (e.g. electro mechanical device)		
Airborne demonstration sortie		
Simulator Recovery from Unusual attitudes with IP		
Airborne Recovery from Unusual attitudes with IP		
OTHER (please specify)		

o. If you have any further comments to make about this sortie or aeromedical and flight training in Spatial Disorientation in general, please do so below.

Appendix C.
Lesson Plan

April 1997

SPATIAL DISORIENTATION DEMONSTRATION FLIGHT

TABLE OF CONTENTS

SECTION I. - ADMINISTRATIVE DATA

1. TASK(S) TAUGHT OR SUPPORTED:

TASK NUMBER	TASK TITLE
N/A	N/A

2. TASK(S) REINFORCED:

TASK NUMBER	TASK TITLE
N/A	N/A

3. ACADEMIC/FLIGHT HOURS:

	PEACETIME HOURS/TYPE	MOBILIZATION HOURS/TYPE
ACADEMIC	0.1/CO	0.1/CO
FLIGHT	0.4/PE	0.4/PE
TEST	.0	.0
TEST REVIEW	.0	.0
TOTAL HOURS	0.5	0.5

4. LIST THE LESSON NUMBER IN WHICH THE TERMINAL LEARNING OBJECTIVE/ENABLING LEARNING OBJECTIVE IS TESTED AND THE TEST RESULTS ARE REVIEWED: See above.

	HOURS	LESSON NO
TESTING:	N/A	N/A
REVIEW OF THE TEST RESULTS:	N/A	N/A

5. PREREQUISITE LESSON: LP-4505 (Spatial Disorientation and Sensory Illusions of Flight)

6. CLEARANCE AND ACCESS: Unclassified; foreign students may attend this class.

7. REFERENCES:

NUMBER	TITLE	PAGES	ADDITIONAL INFORMATION
FM 1-301	AEROMEDICAL TRAINING FOR FLIGHT PERSONNEL	8-1 - 8-13	Chapter 8
FM 8-2	AEROSPACE MEDICINE	330 - 371	Chapter 6

8. STUDENT STUDY ASSIGNMENT: None.

9. INSTRUCTOR REQUIREMENTS: One flight surgeon (primary instructor) and one UH-1 pilot-in-command (to perform flight maneuvers). (NOTE: A UH-1 instructor pilot is desirable, but not necessary.) The flight surgeon will be seated in the cockpit seat not used by the PIC.

10. ADDITIONAL SUPPORT PERSONNEL REQUIREMENTS: None.

11. EQUIPMENT REQUIRED FOR THE INSTRUCTION: One UH-1 helicopter with 3 forward-facing passenger seats, an intercom system which accommodates all crew and passengers, and flight protective clothing and equipment per AR 95-1 (dark visor on helmet).

12. MATERIALS REQUIRED FOR THE INSTRUCTION:

INSTRUCTOR MATERIALS: Spatial Disorientation Demonstration Flight Lesson Plan.

STUDENT MATERIALS: None.

13. CLASSROOM, TRAINING AREA, AND/OR RANGE REQUIREMENTS: A flight training area and stage field or landing zone (LZ) with low aviation activity is desirable.

14. AMMUNITION REQUIREMENT: None.

15. INSTRUCTIONAL GUIDANCE: The UH-1 pilot-in-command (PIC) will be proficient in the required enabling learning objective (ELO) flight maneuvers and will perform all ELO flight maneuvers within the standards established in Technical Circular (TC) 1-211 (Aircrew Training Manual, Utility Helicopter, UH-1).

16. LESSON PLAN WRITTEN BY:

NAME	RANK	POSITION	DATE
ARTHUR ESTRADA III	CIV	SIMULATOR IP, FLT SYS BR	11 APR 97

17. PROPONENT LESSON PLAN APPROVAL AUTHORITY:

NAME	RANK	POSITION	DATE
MALCOLM G. BRAITHWAITE	LTC	C, SPATIAL DIS-ORIENTATION TEAM	11 APR 97

NAME	RANK	POSITION	DATE
JEFFREY C. RABIN	LTC	DIRECTOR, AHPD	11 APR 97

NAME	RANK	POSITION	DATE
DENNIS F. SHANAHAN	COL	COMMANDER, USAARL	11 APR 97

18. BRANCH SAFETY OFFICER APPROVAL:

NAME	RANK	POSITION	DATE

ANNUAL REVIEW

PRINTED NAME OF PERSON REVIEWING LESSON DATE REVIEWED

PRINTED NAME OF PERSON REVIEWING LESSON DATE REVIEWED

PRINTED NAME OF PERSON REVIEWING LESSON DATE REVIEWED

PRINTED NAME OF PERSON REVIEWING LESSON DATE REVIEWED

PRINTED NAME OF PERSON REVIEWING LESSON DATE REVIEWED

SECTION II. - INTRODUCTION

Method of Instruction: PE. Instructor to student ratio is 1:3.

Time of Instruction: 0029 minutes.

Media: None.

Motivator:

NOTE: The flight surgeon will begin the introduction phase immediately following the passenger safety briefing conducted by the PIC.

NOTE: The flight surgeon may use a motivator of his or her choice, however, he or she must ensure that it gains the students' attention, states the need for this training, and explains the terminal learning objective (TLO). A suggested motivator follows:

"There appears to be a killer stalking Army aviation. When it strikes, pilots are unable to see, believe, interpret, or process the information on their flight instruments. Instead, they rely on false information their senses provide, becoming victims of spatial disorientation (FLIGHTFAX, February 1997). Our goal today is to reinforce the academic instruction you've already received and to allow you to experience the physiological limitations of your orientation senses during actual flight. This training will enhance your awareness of potentially disorienting situations, allowing you to recognize what is happening, and how best to prevent it from happening."

1. TERMINAL LEARNING OBJECTIVE (TLO):

<u>NOTE</u>: Read the TLO requirements to the students.

At the completion of this lesson the student will:

ACTION: Be aware of the physiological limitations of the orientation senses and how to best prevent spatial disorientation.

CONDITION: In a UH-1 helicopter, secured in a forward-facing passenger seat.

STANDARD: Standard: In accordance with (IAW) FM 1-301, <u>Aeromedical Training For Flight Personnel</u>.

SAFETY REQUIREMENTS: The PIC will ensure that the students receive a full passenger safety briefing IAW TM 55-1520-210-10 prior to the flight.

<u>NOTE</u>: During the conduct of the various ELO flight maneuvers, there will be periods of reduced intercommunications with regard to direction of turns and their magnitudes. Therefore, the observing students will be instructed to assist with airspace surveillance and to feel free to verbalize their concerns whenever safety appears to be compromised.

RISK ASSESSMENT LEVEL: Low.

2. ENVIRONMENTAL CONSIDERATIONS:

a. This demonstration flight will be conducted under visual flight rules (VFR) only. Since the training requires flight at altitudes of at least 500 feet above ground level(AGL), the worst weather should be forecast to be equal to or greater than 1000 feet ceilings and 3 miles visibility during the demonstration flight .

b. Wind speed should not exceed 20 knots. Greater wind speeds will require a reevaluation of the risk assessment level.

EVALUATION: Because this training reinforces material already academically taught and evaluated, there is no formal evaluation. The flight surgeon will provide oral quizzing relating to the physiological senses and spatial disorientation prior to, during and after the flight to ensure continuity of the academic and flight training.

3. INSTRUCTIONAL LEAD IN:

<u>NOTE</u>: The flight surgeon may use an instructional lead in of his or her choice. A suggested instructional lead-in follows:

"The academic classes you attended at the School of Aviation Medicine provided the knowledge necessary to understand your orientation senses and the effects of spatial disorientation. This flight will reinforce that knowledge and provide you with a flight experience which will demonstrate your physiological limitations with regard to spatial orientation."

<u>SECTION III. - PRESENTATION</u>

<u>WARNING</u>: Because the ELO flight maneuvers require short periods during which the verbalization of direction of turns and their magnitudes would defeat the purpose of the training, the PIC and flight surgeon will be especially alert to obstacle and collision avoidance. The flight crew will be thoroughly familiar with each ELO flight maneuver, the sequence in which they will be performed, and the flight training areas in which they will be flown. (This coordination will be conducted during the crew mission briefing prior to the arrival of the students.) During the conduct of the ELO flight maneuvers, the PIC will modify standard terminology. For example, instead of "Clear right?" or "Clear down?," he will request, "Clear to continue the maneuver?." The flight surgeon, knowing the maneuver, will respond, "Clear to continue." If safety is ever compromised, standard terminology <u>will</u> be used to clearly state the situation and the flight maneuver will be immediately terminated.

<u>NOTE</u>: The flight surgeon will begin the presentation phase after takeoff and during the flight to the training area.

<u>NOTE</u>: Inform the students of the Enabling Learning Objective requirements.

1. ENABLING LEARNING OBJECTIVE (ELO) #1:

ACTION: Explanation of ELO flight maneuvers and brief review of orientation senses.

CONDITION: In a UH-1 helicopter, secured in a forward-facing passenger seat, en route to the flight training area.

STANDARD: In accordance with FM 1-301 and FM 8-2.

Learning Step/Activity - Explain individual roles during ELO flight maneuvers and provide a brief review of orientation senses.

Method of instruction: CO. Instructor to student ratio is 1:3.

Time of Instruction: 0003 minutes.

Media: None.

NOTE: Provide general assurance that no violent maneuvers will be performed and that no maneuvers will exceed the aircraft's limitations per Technical Manual (TM) 55-1520-210-10 (Operator's Manual, Army Model, UH-1H/V Helicopters).

a. Explanation of ELO Flight Maneuvers.

(1) Prior to the commencement of each ELO flight maneuver, one of the students will be identified as the subject student." (Each student will be a subject student during at least one high level ELO flight maneuver and one hover ELO flight maneuver.)The subject student will sit free of all airframe structures other than the seat. He or she will lower his/her dark visor and note the aircraft's initial parameters (airspeed, altitude and heading)as provided by the flight surgeon. The subject student will then close his/her eyes and then provide a running commentary of his/her perception of orientation with particular reference to airspeed, altitude, attitude, and heading.

(2) The other students will observe, but not comment, until after the ELO flight maneuver is terminated.

(3) At the completion of each ELO flight maneuver, the subject student will be instructed when to open his/her eyes. An observing student will be asked to tell the subject student what actually happened and all observing students will be asked for their comments.

b. The flight surgeon will briefly review orientation senses.

(1) Three sensory systems are especially important in maintaining equilibrium, orientation, and balance. They are the proprioceptive system, the vestibular system, and the visual system. Normally, the combined functioning of these senses maintains equilibrium and spatial orientation.

NOTE: The contribution of hearing to orientation is small and variable, e.g., changes in the sound of rotor blade rotation caused by angles of bank. It cannot be relied upon until you have had a great deal of experience in that type of aircraft, and so will not be mentioned further.

(2) Visual sense. Of the three sensory systems, the visual system is the most important in maintaining equilibrium and spatial orientation. (Stress the overwhelming contribution of

vision to orientation and that spatial disorientation is primarily a problem associated with poor external visual conditions. Explain that it is due to the importance of vision that the subject student will be deprived of his/her vision during the subsequent ELO flight maneuvers.)

(3) Vestibular system. This system is the motion- and gravity-detecting organ located in the inner ear. The vestibular apparatus consists of two distinct structures: the semicircular canals (sense angular accelerations) and the otolith organs (sense linear accelerations).

(4) Proprioceptive system. This system reacts to the sensations resulting from pressures on joints, muscles, and skin and also from slight changes in the position of internal organs. NOTE: Conduct a check on learning and summarize the learning step/activity.

2. ENABLING LEARNING OBJECTIVE (ELO) #2:

ACTION: Demonstrate the limitations of performance of the semicircular canals (ELO Flight Maneuver #1).

CONDITION: In a UH-1 helicopter, secured in a forward-facing passenger seat, in the flight training area.

STANDARD: In accordance with FM 1-301, FM 8-2 and TC 1-211.

Learning Step/Activity - Demonstrate, through practical exercise, the limitations of performance of the semicircular canals.

Method of Instruction: PE. Instructor to student ratio 1:3.

Time of instruction: 0003 minutes.

Media: None.

a. TO PREPARE FOR ELO FLIGHT MANEUVER #1.

(1) The flight surgeon will assign the subject student who will then lower his/her dark visor.

(2) The PIC will establish straight and level flight at 90 KIAS, an MSL altitude which results in at least 500 feet AGL and an appropriate heading for the training area.

(3) The flight surgeon will announce the aircraft's airspeed pressure, altitude, and heading. The subject student will then close his/her eyes. (If necessary, under very sunny conditions, the subject students may need to cover their eyes with their hands.)

(4) The flight surgeon will remind and prompt the subject student to provide a running commentary of his/her perception of orientation with particular reference to airspeed, altitude, attitude, and heading.

b. Performance of ELO Flight Maneuver #1.

(1) Ten seconds after the subject student announces eyes closed, the PIC will initiate a gently increasing, yet detectable, left or right roll (5 degrees/second/second) until the aircraft achieves a turn of standard rate. The turn is continued for 360 degrees. The aircraft is then rolled wings-level at a rate that will be easily detected by the subject student. (The rate of roll-out should be approximately twice as fast as the rate of entry or 10 degrees/second/second.)

NOTE: The initial roll is normally detected, but as the semicircular canal response decays, a false sensation of a return to straight and level flight is perceived. As the roll-out to level flight is made, a sensation of turning in the opposite direction is perceived.

(2) After the roll-out, the student is instructed to open his/her eyes once straight and level flight is again perceived.

c. After completion of ELO Flight Maneuver #1.

(1) An observing student will be asked to tell the subject student what actually happened and then all observing students will be asked for their comments.

(2) The flight surgeon will then remind the students of the limitations of the physiology of semicircular canal performance.

NOTE: Conduct a check on learning and summarize the learning step/activity, stressing how easy it is to detect roll by vision, but how difficult it can be when deprived of it.

3. ENABLING LEARNING OBJECTIVE (ELO) #3:

ACTION: Demonstrate the limitations and illusions of the proprioceptive system and vestibular apparatus (ELO Flight Maneuver #2).

CONDITION: In a UH-1 helicopter, secured in a forward-facing passenger seat, in the flight training area.

STANDARD: In accordance with FM 1-301, FM 8-2 and TC 1-211.

Learning Step/Activity - Demonstrate, through practical exercise, the limitations and illusions of the proprioceptive system and the vestibular apparatus.

Method of Instruction: PE. Instructor to student ratio 1:3.

Time of instruction: 0003 minutes.

Media: None.

a. TO PREPARE FOR ELO FLIGHT MANEUVER #2.

(1) The flight surgeon will assign a different student to be the subject student who will then lower his/her dark visor.

(2) The PIC will establish straight and level flight at 90 KIAS, an MSL altitude which results in at least 500 feet AGL and an appropriate heading for the training area.

(3) The flight surgeon will announce the aircraft's airspeed, pressure altitude, and heading. The subject student will then close his/her eyes. (If necessary, under very sunny conditions, the subject students may need to cover their eyes with their hands.)

(4) The flight surgeon will remind and prompt the subject student to provide a running commentary of his/her perception of orientation with particular reference to airspeed, altitude, attitude, and heading.

b. PERFORMANCE OF ELO FLIGHT MANEUVER #2.

(1) Following the subject student's announcement of "eyes closed," the aircraft will be flown with no alteration of airspeed, altitude, or heading.

NOTE: Because of small aircraft movements from turbulence and the aerodynamic response of the helicopter which stimulate the proprioceptive system and/or the vestibular apparatus, students should perceive climbs, descents, or turns in unpredictable and varying amounts.

NOTE: On particularly calm days, minor pilot-induced turbulence may be necessary.

(2) After approximately 90 seconds, the student is instructed to open his/her eyes.

c. AFTER COMPLETION OF ELO FLIGHT MANEUVER #2.

(1) An observing student will be asked to tell the subject student what actually happened and then all observing students will be asked for their comments.

(2) The flight surgeon will then discuss the erroneous sensations produced by brief stimulation of the proprioceptive system and vestibular apparatus.

NOTE: Conduct a check on learning and summarize the learning step/activity.

4. ENABLING LEARNING OBJECTIVE (ELO) #4:

ACTION: Demonstrate the limitations of the otolith organs (ELO Flight Maneuver #3).

CONDITION: In a UH-1 helicopter, secured in a forward-facing passenger seat, in the flight training area.

STANDARD: In accordance with FM 1-301, FM 8-2 and TC 1-211.

Learning Step/Activity - Demonstrate, through practical exercise, the limitations of the otolith organs.

Method of Instruction: PE. Instructor to student ratio 1:3.

Time of instruction: 0004 minutes.

Media: None.

a. To prepare for ELO Flight Maneuver #3.

(1) The flight surgeon will assign the third student to be the subject student who will then lower his/her dark visor.

(2) The PIC will establish straight and level flight at 90 KIAS, an MSL altitude which results in at least 500 feet AGL and a heading which is ideally into the wind.

(3) The flight surgeon will announce the aircraft's airspeed, pressure altitude, and heading. The subject student will then close his/her eyes. (If necessary, under very sunny conditions, the subject students may need to cover their eyes with their hands.)

(4) The flight surgeon will remind and prompt the subject student to provide a running commentary of his/her perception of orientation with particular reference to airspeed, altitude, attitude, and heading.

b. Performance of ELO Flight Maneuver #3.

(1) Following the subject student's announcement of "eyes closed", the PIC will initiate a deceleration which will result in a free air hover in 30-40 seconds. There will be no change of heading or altitude.

NOTE: Both the deceleration and the final nose-up pitch associated with the attitude change when slowing the aircraft usually convinces the student that a climb is taking place. In addition, a turn is often falsely perceived when balance variations are made to maintain straight and level flight.

(2) After establishment of the free air hover, the student is instructed to open his/her eyes.

c. After Completion of ELO Flight Maneuver #3.

(1) An observing student will be asked to tell the subject student what actually happened and then all observing students will be asked for their comments.

(2) The flight surgeon will then discuss the physiological limitations of the otolith organs and the somatogravic illusion.

NOTE: Conduct a check on learning and summarize the learning step/activity.

5. ENABLING LEARNING OBJECTIVE (ELO) #5:

ACTION: Demonstrate physiological limitations of detecting inadvertent descents. (ELO Flight Maneuver #4).

CONDITION: In a UH-1 helicopter, secured in a forward-facing passenger seat, in the flight training area.

STANDARD: In accordance with FM 1-301, FM 8-2 and TC 1-211.

Learning Step/Activity - Demonstrate, through practical exercise, the physiological limitations of detecting inadvertent descents.

Method of Instruction: PE. Instructor to student ratio 1:3.

Time of instruction: 0004 minutes.

Media: None.

a. To prepare for ELO Flight Maneuver #4.

(1) The flight surgeon will assign a subject student who will then lower his/her dark visor.

(2) The PIC will establish straight and level flight at 90 KIAS, an MSL altitude which results in at least 500 feet AGL and an appropriate heading for the training area.

NOTE: This flight maneuver will terminate at terrain flight altitudes, therefore, the PIC will ensure that a safe descent can be made within the training area. Additionally, the PIC should plan the descent so as to terminate the flight maneuver in close proximity to a predetermined stagefield or LZ within which the next three enabling learning objectives will be performed.

(3) The flight surgeon will announce the aircraft's airspeed, pressure altitude, and heading. The subject student will then close his/her eyes. (If necessary, under very sunny conditions, the subject students may need to cover their eyes with their hands.)

(4) The flight surgeon will remind and prompt the subject student to provide a running commentary of his/her perception of orientation with particular reference to airspeed, altitude, attitude, and heading.

b. Performance of ELO Flight Maneuver #4.

(1) After the subject student announces "eyes closed", the PIC will initiate a detectable left or right turn while gently entering an undetectable descent (less than 500 feet per minute). During the descent, it is acceptable for the PIC to perform variable right and left turns. Upon reaching a safe terrain flight altitude, ideally, in close proximity of a predetermined stagefield or LZ, the PIC will establish straight and level flight.

NOTE: The student, remembering ELO Flight Maneuver #2, usually states that he/she has rolled out straight and level, unaware of the change in altitude.

(2) After establishment of straight and level terrain flight, the student is instructed to open his/her eyes.

c. After Completion of ELO Flight Maneuver #4.

(1) An observing student will be asked to tell the subject student what actually happened and then all observing students will be asked for their comments.

(2) The flight surgeon will then discuss how easily a pilot can become unaware of an inadvertent descent in restricted visibility (fog, dust, snow, and night operations).

NOTE: Conduct a check on learning and summarize the learning step/activity.

WARNING: The following ELO flight maneuvers (ELO's #6 through #8) are performed in a landing zone or at a stagefield, therefore, it is imperative that a comprehensive assessment of the hazards be conducted. The terrain should be familiar to the crew, and they and the observing students must maintain good airspace surveillance.

NOTE: During this series of hovering maneuvers, each student will experience being a subject student.

6. ENABLING LEARNING OBJECTIVE (ELO) #6:

ACTION: Demonstrate the ease of becoming spatially disoriented during hovering maneuvers when exposed to linear and rotational accelerations (ELO Flight Maneuver #5).

CONDITION: In a UH-1 helicopter, secured in a forward-facing passenger seat, in a landing zone or at a stagefield.

STANDARD: In accordance with FM 1-301, FM 8-2 and TC 1-211.

Learning Step/Activity - Demonstrate, through practical exercise, the ease of becoming spatially disoriented during hovering maneuvers when exposed to linear and rotational accelerations.

Method of Instruction: PE. Instructor to student ratio 1:3.

Time of instruction: 0003 minutes.

Media: None.

a. To prepare for ELO Flight Maneuver #5.

(1) The flight surgeon will assign the subject student who will then lower his/her dark visor.

(2) The PIC will establish the aircraft in a stable 5 feet hover.

(3) The flight surgeon will announce the aircraft altitude and heading, and make reference to landmarks to the front and sides. The subject student will then close his/her eyes. (If necessary, under very sunny conditions, the subject students may need to cover their eyes with their hands.)

(4) The flight surgeon will remind and prompt the subject student to provide a running commentary of his/her perception of orientation with particular reference to airspeed, altitude, attitude, and heading.

b. Performance of ELO Flight Maneuver #5.

(1) After the subject student announces "eyes closed, the PIC will initiate a variety of hovering, rotating, and translating maneuvers which will provide linear and/or rotational accelerations. During these maneuvers, it is possible to "hide" various maneuvers so as to surprise the subject student with the final orientation of the aircraft. After approximately 45 seconds of the hovering maneuvers, the PIC will end the exercise with the establishment of a backward climb at 10-15 knots.

(2) During the hovering maneuvers, the flight surgeon will keep prompting the subject student for a running commentary (to occupy channels of attention) and thus, precipitate the onset of spatial disorientation.

NOTE: Most students are able to maintain their orientation for 10 to 15 seconds before losing it.

(3) After the backward climb is established, the subject student is instructed to open his/her eyes.

c. After completion of ELO Flight Maneuver #5.

(1) An observing student will be asked to tell the subject student what actually happened and then all observing students will be asked for their comments.

(2) The flight surgeon will discuss the ease in which spatial orientation is lost, particularly in the context of snow, dust, sand and night operations. He/she will also discuss how angular accelerations are detected fairly well, but how linear accelerations are not.

NOTE: Conduct a check on learning and summarize the learning step/activity.

7. ENABLING LEARNING OBJECTIVE (ELO) #7:

ACTION: Demonstrate the ease of becoming spatially disoriented during hovering maneuvers when exposed to linear and rotational accelerations (ELO Flight Maneuver #6).

CONDITION: In a UH-1 helicopter, secured in a forward-facing passenger seat, in a landing zone or at a stagefield.

STANDARD: In accordance with FM 1-301, FM 8-2 and TC 1-211.

Learning Step/Activity - Demonstrate, through practical exercise, the ease of becoming spatially disoriented during hovering maneuvers when exposed to linear and rotational accelerations.

Method of Instruction: PE. Instructor to student ratio 1:3.

Time of instruction: 0003 minutes.

Media: None.

a. To prepare for ELO Flight Maneuver #6.

(1) The flight surgeon will assign a different subject student who will then lower his/her dark visor.

(2) The PIC will establish the aircraft in a stable 5 feet hover.

(3) The flight surgeon will announce the aircraft altitude, heading and make reference to landmarks to the front and sides. The subject student will then close his/her eyes. (If necessary, under very sunny conditions, the subject students may need to cover their eyes with their hands.)

(4) The flight surgeon will remind and prompt the subject student to provide a running commentary of his/her perception of orientation with particular reference to airspeed, altitude, attitude, and heading.

b. Performance of ELO Flight Maneuver #6.

(1) After the subject student announces "eyes closed," the PIC will initiate a variety of hovering, rotating and translating maneuvers which will provide linear and/or rotational accelerations. During these maneuvers, it is possible to "hide" various maneuvers so as to surprise the subject student with the final orientation of the aircraft. After approximately 45 seconds of the hovering maneuvers, the PIC will very gently land the aircraft without the subject student realizing it.

(2) During the hovering maneuvers, the flight surgeon will keep prompting the subject student for a running commentary (to occupy channels of attention) and thus, precipitate the onset of spatial disorientation.

<u>NOTE</u>: Most students are able to maintain their orientation for 10 to 15 seconds before losing it.

(3) After the aircraft is gently landed, the subject student is instructed to open his/her eyes.

c. After completion of ELO Flight Maneuver #6.

(1) An observing student will be asked to tell the subject student what actually happened and then all observing students will be asked for their comments.

(2) The flight surgeon will discuss the ease in which spatial orientation is lost, particularly in the context of snow, dust, sand and night operations. He/she will also discuss how angular accelerations are detected fairly well, but how linear accelerations are not.

NOTE: Conduct a check on learning and summarize the learning step/activity.

8. ENABLING LEARNING OBJECTIVE (ELO) #8:

ACTION: Demonstrate the ease of becoming spatially disoriented during hovering maneuvers when exposed to linear and rotational accelerations (ELO Flight Maneuver #7).

CONDITION: In a UH-1 helicopter, secured in a forward-facing passenger seat, in a landing zone or at a stagefield.

STANDARD: In accordance with FM 1-301, FM 8-2 and TC 1-211.

Learning Step/Activity - Demonstrate, through practical exercise, the ease of becoming spatially disoriented during hovering maneuvers when exposed to linear and rotational accelerations.

Method of Instruction: PE. Instructor to student ratio 1:3.

Time of instruction: 0003 minutes.

Media: None.

a. To prepare for ELO Flight Maneuver #7.

(1) The flight surgeon will assign a different subject student who will then lower his/her dark visor.

(2) The PIC will establish the aircraft in a stable 5 feet hover.

(3) The flight surgeon will announce the aircraft altitude, heading and make reference to landmarks to the front and sides. The subject student will then close his/her eyes. (If necessary, under very sunny conditions, the subject students may need to cover their eyes with their hands.)

(4) The flight surgeon will remind and prompt the subject student to provide a running commentary of his/her perception of orientation with particular reference to airspeed, altitude, attitude, and heading.

b. Performance of ELO Flight Maneuver #7.

(1) After the subject student announces "eyes closed", the PIC will initiate a variety of hovering rotating and translating maneuvers which will provide linear and/or rotational accelerations. During these maneuvers, it is possible to "hide" various maneuvers so as to surprise the subject student with the final orientation of the aircraft. After approximately 45 seconds of the hovering maneuvers, the PIC will end the exercise with a gentle transition to forward flight.

(2) During the hovering maneuvers, the flight surgeon will keep prompting the subject student for a running commentary (to occupy channels of attention) and thus, precipitate the onset of spatial disorientation.

NOTE: Most students are able to maintain their orientation for 10 to 15 seconds before losing it.

(3) After the transition to forward flight is completed, the subject student is instructed to open his/her eyes.

c. After completion of an ELO Flight Maneuver #7 exercise.

(1) An observing student will be asked to tell the subject student what actually happened and then all observing students will be asked for their comments.

(2) The flight surgeon will discuss the ease in which spatial orientation is lost, particularly in the context of snow, dust, sand and night operations. He/She will also discuss how angular accelerations are detected fairly well, but how linear accelerations are not.

NOTE: Conduct a check on learning and summarize the learning step/activity.

SECTION IV. - SUMMARY

Method of Instruction: CO. Instructor to student ratio is 1:3.

Time of Instruction: 0003 minutes.

Media: None.

1. REVIEW/SUMMARIZE

a. On the return flight to the basefield, the flight surgeon will discuss the Spatial Disorientation Demonstration Flight. He/She will make particular reference to the significance of undetectable maneuvers and erroneous sensory information cues.

b. The students are reassured that they are all physiologically normal, but just not "designed" for flight. The objective of the demonstration flight was to provide them with an idea of the limitations of the own physiology in the environment in which they operate and the phases of flight commonly associated with spatial disorientation.

c. Advise the students that the best way to avoid and counter the effects of spatial disorientation is to achieve a working knowledge of the limitations of the orientation senses and to maintain proficiency at instrument flying.

2. CHECK ON LEARNING.

a. Solicit student questions and explanations.

b. Questions and answers.

NOTE: No specific questions are required. The flight surgeon can quiz any demonstrated weak areas.

c. Correct students misunderstandings.

3. TRANSITION TO NEXT LESSON. N/A.

SECTION V. - STUDENT EVALUATION

1. TESTING REQUIREMENTS: None.

2. FEEDBACK REQUIREMENTS: None.

Appendix D.
Critique sheet

Please enter today's date and your IERW class number.

Date__________________ Class Number___________________

No matter whether you were a "subject" (i.e. had your eyes closed) or an "observer" (i.e. were watching the reaction of the subject) please rate all of the demonstration maneuvers.

Maneuver 1 : Level Turn

CHECK ONE BOX ONLY. For this maneuver I was the subject ☐ an observer ☐

How successful would you rate the first maneuver in its ability to convince you that it is difficult for you to sense motion and attitude without aircraft instruments?

Please rate this maneuver between 0 (extremely poor) and 10 (extremely good) ____________

Maneuver 2 : Maintain straight and level

How successful would you rate the second maneuver (maintain straight and level) in its ability to convince you that random motion experienced in flight (e.g., turbulence) can give you wrong information.

CHECK ONE BOX ONLY. For this maneuver I was the subject ☐ an observer ☐.

Please rate this maneuver between 0 (extremely poor) and 10 (extremely good)____________

Maneuver 3 : Deceleration to a free air hover

How successful would you rate the third maneuver (deceleration to a free air hover) in its **combined** ability to demonstrate **both** the illusion of climbing when the aircraft is pitched nose up, and the inability to accurately detect airspeed changes without reference to flight instruments.

CHECK ONE BOX ONLY. For this maneuver I was the subject ☐ an observer ☐

Please rate this maneuver between 0 (extremely poor) and 10 (extremely good) ____________

Maneuver 4 : Inadvertent descent

How successful would you rate the fourth maneuver (inadvertent descent) in its ability to convince you that it is difficult to accurately sense the position, motion, and attitude of the aircraft when close to the ground in conditions of poor visibility.

CHECK ONE BOX ONLY. For this maneuver I was the subject ☐ an observer ☐

Please rate this maneuver between 0 (extremely poor) and 10 (extremely good)____________

Please turn page over

Hover maneuvers

You will have been a **subject** on one occasion for hover maneuvers and an **observer** on two occasions.

As a subject: How successful would you rate this demonstration in its ability to convince you that it is difficult to accurately sense the position, motion and attitude of the aircraft when close to the ground in conditions of poor visibility.

Please rate the demonstration between 0 (extremely poor) and 10 (extremely good)____________

As an observer: How successful would you rate these demonstrations in their ability to convince you that it is difficult to accurately sense the position, motion and attitude of the aircraft when close to the ground in conditions of poor visibility.

Please rate these demonstrations (extremely poor) and 10 (extremely good)____________

OVERALL ASSESSMENT

a. **Overall**, how well did this demonstration sortie show the limitations of the orientational senses in flight?

Please rate the whole demonstration between 0 (extremely poor) and 10 (extremely good)____________

b. Compared with your **awareness** of the limitations of the orientational senses in flight **before** the sortie, how would you rate your knowledge now?

(Please place an **X** at the point on the scale below that most clearly represents your opinion.)

I know nothing about SD | Worse than before | The same as before | Better than before | Totally enlightened

Thank You - please return this form to the flight surgeon